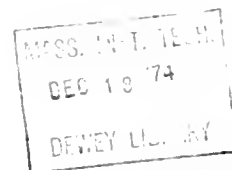




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MODEL RELATIVISM:
A SITUATIONAL APPROACH TO MODEL BUILDING

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ABSTRACT

A model is not a theory. A theory implies "best possible" representation of a situation and should, (for a given analyst, at least), be unique. An analyst, however, may build several "right" models of a particular situation, each for a different use or user. Model relativism, the explicit consideration of the use and user in model development, has important implications for building models, for implementing those models and for developing teaching programs. Some of those implications are explored in this paper.

1. Introduction

Why are so many models built and so few used? There are many answers to this question, and I won't try a complete diagnosis here. However, I hope to provide some insight into two aspects of that question:

(a) Why do some models seem doomed to failure from conception?

(b) What do we (1) mean by "used"?

Much has been written about modelling and model-building. Urban [6] cites much of the related literature; the reference list of that paper is useful for those studying the modelling process. My favorite treatment of this theme is included in the chapters of Ackoff and Sasieni [1] which treat problem recognition, modelling, testing, implementation and control. The reader can keep his own most helpful model-writer in mind; they all suffer from the same pedagogic weakness -- they help good modellers be better modellers and don't do nearly as much for the "have-nots".

Why? I think the answer lies in the reason our model-writer chooses to write on the subject in the first place. He has had years of experience working on a large enough variety of problems to provide many of what he classifies as "good" as well as "not so good" experiences. Then, as compulsive analysts will do, he has performed a discriminant analysis (formal or informal) and has tried to determine the critical factors in his successful works. In so doing he describes what, for him, is a successful pattern. So far, okay. But in trying to transfer that knowledge, he is, I believe, destined to fail.

I do not believe one can really learn from the experience of another, and herein lies the problem. The brilliant, abstract principles that the model-writer describes have the richness of his experiences behind them

when he rereads them. That is precisely because he has had those experiences. The naive reader, confronted with the same principles, finds them bland truisms, and rather abstract as well. He has no such experience base to put meat on these abstract principles.

A favorite principle of mine is that one should analyze any problem-situation thoroughly before suggesting a solution strategy. That analysis, if done carefully, will unearth some "special structure" which will greatly facilitate solution. For example, consider allocating a fixed advertising budget among areas with general response curves -- a very tough problem! However, if those curves are found to be concave, the solution -- equating marginal returns -- is just about trivial. My special structure principle, read objectively, is as trite and seemingly devoid of operational content as any I've encountered, yet it has tremendous importance for me. In successful work, I've consciously sought the "special structure" and have usually located it.

The above can be viewed as a caveat. I will be describing my views of modelling here. They seem profound and extremely insightful to me. They may appear trite and obvious to the reader. By my argument above, I can, at best, hope to reach a limited audience so I beg the reader's indulgence.

II. Model Relativism vs. Model Absolutism

I define the terms in this section's title as follows:

Model Absolutism (MA): that school of thought which would have one believe that (only) one model best describes a situation.

The followers of this school feel there is a one-to-one relationship between a model and a theory. Since only one model (the best, in an

absolute sense, subject to the Law of Parsimony) can be used, at least by a particular theorist or analyst, to represent a particular situation, that model constitutes the analyst's theory of how that situation operates. A statistical test, for example, on model-parameters can then constitute a test of the theory.

Model Relativism (MR): the school of thought which holds that several or many models can be employed to describe a situation, depending on both the user (technically skeptical manager versus sophisticated analyst, e.g.) and the use (long range planning versus short range scheduling, e.g.).

The MRist says, "Nonsense!" to the MAist model-theory association. He believes, for example, that the best "theory" of consumer behavior currently available, while useful to researchers, perhaps should not be proposed for use in a particular situation where the marketing manager or decision maker can't understand it and thus won't use it. The best representation of consumer behavior which the manager can understand, accept and feel comfortable with can be the best model in an MR sense. We assume that if we remove the main barriers-to-use (understanding and applications difficulties) then the manager may use the model. Clearly, if after believing in the model, the manager's model-budget runs out, he won't use it. The barrier issue has been partially discussed by Little [3], through his "adaptive", "easy to understand" and "controllable" model criteria. What the MRist would add is that the model design should adapt to changing users as well as to changing situations.

Another issue under the general heading of barriers is that of "face validity". A model that tracks and predicts well may not include one or more variables a manager considers important. The excluded variable may

for instance be highly correlated with an included variable. No matter why -- the manager cannot accept the model because of this perceived omission. Then the model builder may be forced to include a variable which adds little or no power to the model to obtain managerial acceptance. Thus model complexity, as a constraint against use, can be either an upper or lower bound.

The MR viewpoint suggests why certain directions of modelling have been much less fruitful than others, both in a theory-development and in an implementation sense. Morrison [5] develops an insightful treatment of both these issues in the particular area of brand-switching models. He concludes that brand switching models of the types described in Massy, Montgomery and Morrison [4] cannot provide testable theories of brand choice behavior. At best, they are useful approximations to real behavior. And most, (except some recent developments in [2] and [6]), do not have explicit normative or decision-making implications. In addition, their mathematical structure makes them difficult for managers to understand and, hence, trust. They have therefore been little used for marketing decision making. Thus, these models rank low on theory-development and on implementation as well. Interest in this model area is waning.

Should we reject stochastic brand-switching models as useless? Perhaps not. They may, in fact, have several uses. First, considering some of the above mentioned normative work, they may have potential for management science-oriented marketing decision makers. If, in fact, the added richness (in terms of explicit modelling of individual differences and uncertainty) is sufficiently valuable to justify the additional management education needed for use, potential may exist here.

Another use exists as well. These models can provide valuable input for classroom discussion for teaching consumer behavior theory. Marketing students need to develop an understanding of the implications of buyer uncertainty on the purchase process. Studying stochastic models of buyer behavior can be very helpful in developing such an understanding, albeit in an abstract sense. The use of models for teaching programs will be developed more completely in the next section.

In this (somewhat digressive) discussion of brand switching models, we have described at least three uses. There may well be more, but those model uses are sufficiently different and of independent importance to list and review:

1. Pedagogic: for use in teaching and explanation. These models should be simple, unencumbered by details, easy to follow and only, perhaps, suggestive of real applications. Models should be designed to help structure thought at the expense of application-detail.
2. Managerial: the best model-representation of the situation still understandable and acceptable to the user. At one limit, it is equivalent to the Theory Representative use (below), at the other extreme it may be even simpler than the Pedagogic models above.
3. Theory Representative: the analyst's "best possible, state of knowledge, representation of the most vital aspects of the situation." This model is as complex as the situation demands, its complexity constrained only by the Principle of Parsimony.

Before leaving this topic, consider the historical development of the MA1st tradition. Model building began with attempts to model fairly well behaved physical systems. The modelling problems that faced Galileo and Newton, complicated as they were, involved very few important variables in (analytically) simple relationships. There was little need for consideration of the user or use in model development.

Recently, more complicated man-machine systems with uncertain behavioral components have been modelled. Choices must be made about the variables to include, and exclude, the portions of the system to model and the level of detail to be considered. Different models of the same system are developed by different people. It sounds disturbing but is understandable: these "systems" are less well defined and different analysts attach different utilities to different system-aspects. Two analysts might easily come up with the same mathematical formulation of an assembly line balancing problem; the same formulation would be quite unlikely from two analysts working on an overall corporate strategy or planning problem.

Thus, we must consider analyst influence factors in explaining differences in models. Not only would the MR1st hold that the best model of a situation depends on the proposed model-use, but, moreover, the "best" model could well depend, for complicated systems, on a qualitative analyst-style factor.

III. MODEL USE -- WHAT CAN IT MEAN?

The term "use" (referring to models) can mean different things. This ambiguity is at the heart of the communications problem faced by model builders and users. I list below a set of model uses, neither mutually exclusive nor exhaustive, but at least indicative of a range of uses:

1. Conceptualization: Often the first level of abstraction, a flow chart or simple, relationship-graph to indicate the nature of relationships. Models help in early steps toward alternate model development. Conceptual models are (generally) of more use to the model builder than the model user if user and builder are not the same person. One might place the bulk of classroom-models in the conceptual model class, as they are more helpful in thinking about reality than in decision making.
2. Description: Models can be used to describe how a system operates. Descriptive models contain no manager-controllable variables but are used to forecast events when independent variables are assumed known. A time series sales-forecast, $Sales = f(Time)$, is a descriptive model, which may be used for budget or logistics planning.
3. Experimentation; Exploration: A model's response in alternative environments can be probed via experimentation. Experimentation is used to explore the response and characteristics of a system; models are developed to use in experiments when it is too costly, destructive, or otherwise infeasible to experiment on the real system. Exploration, as in heuristic programming is a systematic, sequential, way of trying out alternatives and improving actions. A model may be used as a vehicle on which to test a heuristic procedure.
4. Prescription: Models are developed to advise managers as to what they should do in a given situation -- thus they "prescribe." The output of an "experiment" or "exploration" may be a prescription or it may not. The model, $Sales = f(Advertising)$, can be used for setting the levels of a controllable variable, advertising, when the related

fixed and variable costs are known. Prescriptive models contain controllable variables and can generally be manipulated to obtain "good" or "optimal" levels of those variables.

There are clearly other uses for models -- they can also be used to entertain and amuse (as dolls, model airplanes, e.g.). The important point here again is that different uses do exist.

For some, "use" of a model only implies replacement or elimination of human thought at some stage of a decision process. For the MRist "use" can mean aid in teaching or idea operation, aid, however minor, in decision making or aid in theory construction or testing.

IV. Implications for Teaching Programs

Management Scientists are generally called upon to train two distinct classes of students: future model developers and future model users. Since the two classes are almost disjoint, it is interesting that many schools of management do not treat them as such, either through course offerings or differing training programs. That observation aside, I state what I think we should do in the "best of all possible worlds" rather than what the ignorance of our committees on instruction or the stinginess of our alumni force us to do.

IV-1. The Role of Methods Courses in Management Training

Ask any future GM President in your own school of management what he hopes to get out of the quantitative methods course he is currently taking and he is likely to answer, "An 'A'." (The future GM Vice President would answer, "A 'B'".) Well, what should he answer? The reasons for his having

to take a "methods" course are frequently unclear to him, as well as to his instructor who may think he is training graph theorists. He (they) may think it relates to the school's goal of making a Renaissance Man of him. I suggest there are some important reasons for these methods courses which lead directly from the MR view of modelling.

Let us assume our beleaguered MBA candidate is studying queueing theory, of all things, this week. He is presented with the M/M/1 queue in all its analytic beauty. What use, M/M/1? I suggest there are at least three (and we will assume here that our MBA goes on to study Transportation Networks next and will see no more queues):

A. Groundwork: The human mind best reasons from the simple to the complex and not vice versa, as we ask it to do eternally. It also reasons best from the specific to the general. If we give it the simplest, specific case to start with, it can go further most easily. If our MBA ever sees a waiting line problem again, he will know it is at least more complex than the one he has studied. He will also have some feel for the way one measures the performance of such things and will be in the right position to begin further analysis.

B. Limits and Assumptions: As a manager, a little later on his path to the top, suppose one of his technical analysts presents the results of his study, "Gas Station Site Sizing as an M/M/1

Queueing Problem." Our future oil baron asks (after scouring his attic for his old notes): "Don't customers arrive in cyclical patterns during the day?" "Aren't service times for big cars larger than those for little cars? or motorcycles?" "What about customers who come in for repairs?" "Don't customers usually get a nasty glare after they ask for a clean windshield when others are waiting (i.e., doesn't expected service time go down with increasing queue size)?" "Only one server?" And so forth. The point is: he may not remember how or have the tools to do the analysis himself, but he knows what assumptions were made in the analysis he reviewed and he knows, therefore, the limitations of that analysis. That analysis still may be best, in an MR sense, but he always knows what it can't do as well as what it can.

- C. Discipline: I'm sure to get threatening mail for bringing this one up. A great manager is analytic as well as intuitive. He makes decisions after analyzing and understanding a situation and its uncertainties to the limits of his ability. He cannot tolerate inconsistencies in his reasoning, or results that "don't feel right" -- sloppy thinking of any kind. Quantitative methods courses are a potential train-

ing ground for analytic, consistent, un-sloppy thinking. Here one is forced to state assumptions, show data, explore methods of analysis and report results. A critic cannot just say, "I don't like these results," because results follow from the data, analysis and assumptions. The critic must be more specific: suppose he doesn't like one of the assumptions. Change it -- do the results change? If not, no problem. If they do, argue about the assumptions, only! The same holds for data and methods. But the models and methods are exposed and arguments of opinion are replaced by arguments of substance. Quantitative methods courses provide this in microcosm, and if taught (and received) properly can be helpful in developing analytic thinking.

IV-2. How Should Modelling be Taught to Builders

There are those who say either you have it or you don't. I am a gray area man myself and I believe you can lighten the dark gray or make the dark gray black if you work at it.

A. The MR concept must be made clear; that is, the use and user must be included in the studies our Future Model Builder (FMB) performs. Give him the Gas Station Queueing Problem, ask him (1) to model it so as to get the concepts and dynamics of queues across to a class of MBA - general managers

in two lectures; (2) to model it for an experienced, but technically naive manager; (3) to model it for a Ph.D. dissertation on that particular queueing phenomenon.

He is likely to select the M/M/1 queue for (1), a simple simulation model (but one which satisfies the objection of our MBA in (III-12) for (2) and, hopefully do something very much more profound for (3). His response for (3) should probably include (2) as a special case just as (2) probably will include (1). But notice, three different models will still have been generated, even if they are hierarchical.

B. Most experienced modellers know a few examples of "excellent" models and know quite a few very "bad" models. Give a mixture of papers describing these models -- uncriticised. Let the FMB sort them himself. What criterion did he use for discrimination? Making this discrimination process explicit sharpens it and clarifies it and exposes it to criticism (and hence update and improvement).

C. Expose students to ill-structured situations in the form of cases, or, if possible, real organizational problems. Either by simulation (through cases) or in actual practice, different models, in the MR sense, should be developed for similar problems in different managerial or organizational settings.

D. Have the FMB take methods courses. He needs them for the same reason as the MBA-manager. But he also needs them to be secure in his analysis. Only if he has a complete set of keys can he feel certain that he should make a new one for his particular lock. And he might be tempted to use his sledge-hammer if it is the only "key" he has.

E. Have the FMB take readings courses. One understands models best by forcing oneself to "work it out." Journals provide a playground for analytic muscle-flexing. Readings courses can be used to develop both quantitative skills and appreciation and understanding of model building.

F. Builders generally have to "sell" their models at some time. Have FMB's in a marketing models course (say) "sell" their services to students involved in projects in a marketing management course. The results could be interesting and valuable (if frustrating) for both sides.

Clearly this list is incomplete and much is debatable. But explicit consideration of the MR approach should clarify and resolve many of the teaching issues that arise with respect to modelling.

V. The MR Recommendation: A Utility Theory for Models

Let's develop at least an implicit utility theory for models. A model's use and acceptability have many dimensions and the weights (and interactions) of those dimensions are relative to the situation, the use and the user. Goodness of fit, predictive ability, parsimony are three such dimensions. One could suggest others: robustness, ease of use in decision making, ease of updating and maintenance, adaptiveness, costlines to support and operate, etc. This list is far from complete and, of course, the factors could be highly intercorrelated.

A model would be considered "dominant" if it ranked above all competing models along all dimensions of evaluation. And a model would be "dominated" if there existed at least one model which had a higher rating along all dimensions. The dominated models could be eliminated from consideration for a particular application while others could be considered.

This formalizes the informal procedure that model-critics have used all along. It will allow arguments about particular models to reduce to discussion of the relative importance of model attributes. And this is the real issue.

It would be interesting to have "users" and "builders" rate a number of well-known models and develop weights for the various dimensions. This is work for the future, however.

Clearly, the explicit consideration of such a utility theory can only be useful for "important" modelling efforts. However, at least an informal consideration of these trade-offs could be valuable generally in improving model building efforts.

VI. Conclusion

The MR or situational approach to model building, while perhaps not offering much that is new, at least labels the alternatives. By naming these alternatives, options can be more readily identified and modelling objectives can be made more specific.

By providing labels, we can also make our arguments sharper and focus only on points of disagreement. Modellers spend almost unlimited time arguing that Model A is better than B without specifically labelling preference criteria. Perhaps some hot air will be saved by this effort.

A real benefit may be in teaching programs. If teachers can better clarify the different methods of building and using models, then perhaps better modelers and higher implementation rates will result. I hope so.

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